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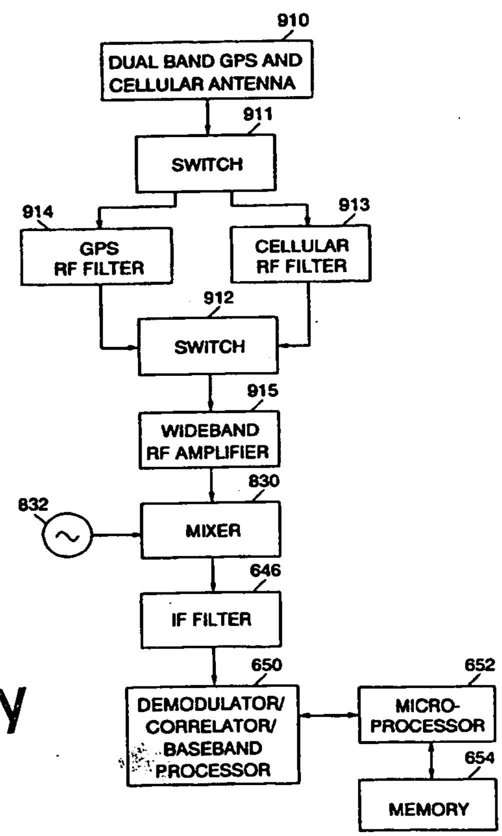
(54) Title: COMBINED GPS AND WIDE BANDWIDTH RADIOTELEPHONE TERMINALS AND METHODS

(57) Abstract

Wireless mobile terminals include a GPS Radio Frequency (RF) receiver and a wide bandwidth radiotelephone RF receiver having bandwidth that is at least half as wide as the GPS RF signal chip frequency. The wireless mobile terminals also include a shared Intermediate Frequency (IF) section that is responsive to both the GPS RF receiver and to the wide bandwidth radiotelephone RF receiver. A demodulator such as a CDMA despreader is responsive to the shared IF section. Thus, common circuitry may be provided except for the separate GPS RF receiver and wide bandwidth radiotelephone RF receiver. Low cost manufacturing and high efficiency operations may thereby be provided.



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COMBINED GPS AND WIDE BANDWIDTH RADIOTELEPHONE TERMINALS AND METHODS

Field of the Invention

The present invention generally relates to wireless communications systems and methods, and more particularly, to receivers for wireless mobile terminals.

Background of the Invention

Wireless communication systems are commonly employed to provide voice and data communications to a plurality of subscribers within a prescribed geographic area. For example, analog cellular radiotelephone systems, such as those designated AMPS, ETACS, NMT-450, and NMT-900, have been deployed successfully throughout the world. Recently, digital cellular radiotelephone systems such as those designated IS-54B (and its successor IS-136) in North America and GSM in Europe have been introduced and are currently being deployed. These systems, and others, are described, for example, in the book entitled *Cellular Radio Systems*, by Balston, et al., published by Artech House, Norwood, MA (1993). In addition to the above systems, an evolving system referred to as Personal Communication Services (PCS) is being implemented. Examples of current PCS systems include those designated IS-95, PCS-1900, and PACS in North America, DCS-1800 and DECT in Europe, and PHS in Japan. These PCS systems operate at the 2 gigahertz (GHz) band of the radio spectrum, and are typically being used for voice and high bit-rate data communications.

FIG. 1 illustrates a conventional terrestrial wireless communication system **20** that may implement any one of the aforementioned wireless communications standards. The wireless system may include one or

more wireless mobile terminals **22** that communicate with a plurality of cells **24** served by base stations **26** and a Mobile Telephone Switching Office (MTSO) **28**. Although only three cells **24** are shown in FIG. 1, a typical cellular radiotelephone network may comprise hundreds of cells, may include more than one MTSO **28** and may serve thousands of wireless mobile terminals **22**.

The cells **24** generally serve as nodes in the communication system **20**, from which links are established between wireless mobile terminals **22** and an MTSO **28**, by way of the base stations **26** servicing the cells **24**. Each cell **24** will have allocated to it one or more dedicated control channels and one or more traffic channels. The control channel is a dedicated channel used for transmitting cell identification and paging information. The traffic channels carry the voice and data information. Through the communication system **20**, a duplex radio communication link **30** may be effected between two wireless mobile terminals **22** or between a wireless mobile terminal **22** and a landline telephone user **32** via a Public Switched Telephone Network (PSTN) **34**. The base station **26** generally handles the radio communications between the cell **24** and the wireless mobile terminal **22**. In this capacity, the base station **26** may function as a relay station for data and voice signals.

FIG. 2 illustrates a conventional celestial wireless communication system **120**. The celestial wireless communication system **120** may be employed to perform similar functions to those performed by the conventional terrestrial wireless communication system **20** of FIG. 1. In particular, the celestial wireless communication system **120** typically includes one or more satellites **126** that serve as relays or transponders between one or more earth stations **127** and satellite wireless mobile terminals **122**. The satellite **126** communicates with the satellite wireless mobile terminals **122** and earth stations **127** via duplex communication links **130**. Each earth station **127** may in turn be connected to a PSTN **132**, allowing communications between the wireless mobile terminals **122**, and communications between the

wireless mobile terminals **122** and conventional terrestrial wireless mobile terminals **22** (FIG. 1) or landline telephones **32** (FIG. 1).

The celestial wireless communication system **120** may utilize a single antenna beam covering the entire area served by the system, or as shown in FIG. 2, the celestial wireless communication system **120** may be designed such that it produces multiple, minimally-overlapping beams **134**, each serving a distinct geographical coverage area **136** within the system's service region. A satellite **126** and coverage area **136** may serve a function similar to that of a base station **26** and cell **24**, respectively, of the terrestrial wireless communication system **20**.

Thus, the celestial wireless communication system **120** may be employed to perform similar functions to those performed by conventional terrestrial wireless communication systems. In particular, a celestial radiotelephone communication system **120** may have particular application in areas where the population is sparsely distributed over a large geographic area or where rugged topography tends to make conventional landline telephone or terrestrial wireless infrastructure technically or economically impractical.

As the wireless communication industry continues to advance, other technologies will most likely be integrated within these communication systems in order to provide value-added services. One such technology being considered is a Global Positioning System (GPS). Therefore, it would be desirable to have a wireless mobile terminal with a GPS receiver integrated therein. It will be understood that the terms "global positioning system" or "GPS" are used to identify any spaced-based system that measures positions on earth, including the GLONASS satellite navigation system in Europe.

A GPS system is illustrated in Figure 3. As is well known to those having skill in the art, GPS is a space-based triangulation system using satellites **302** and computers **308** to measure positions anywhere on the earth. GPS was first developed as a defense system by the United States Department of Defense as a navigational system. Compared to other land-based systems, GPS may be unlimited in its coverage, may provide continuous 24-hour coverage regardless of weather conditions, and may be highly accurate. While

the GPS technology that provides the greatest level of accuracy has been retained by the government for military use, a less accurate service has been made available for civilian use.

In operation, a constellation of 24 satellites **302** orbiting the earth continually emit a GPS radio frequency signal **304** at a predetermined chip frequency. A GPS receiver **306**, e.g., a hand-held radio receiver with a GPS processor, receives the radio signals from the closest satellites and measures the time that the radio signals take to travel from the GPS satellites to the GPS receiver antenna. By multiplying the travel time by the speed of light, the GPS receiver can calculate a range for each satellite in view. From additional information provided in the radio signal from the satellites, including the satellite's orbit and velocity and correlation to its onboard clock, the GPS processor can calculate the position of the GPS receiver through a process of triangulation.

Summary of the Invention

It is therefore an object of the present invention to provide wireless mobile terminals having a Global Positioning System (GPS) receiver integrated therein.

It is another object of the invention to provide a wireless mobile terminal having a GPS receiver integrated therein that can be inexpensive to manufacture and efficient in operation.

These and other objects are provided, according to the present invention, by a combined GPS and wide bandwidth radiotelephone wireless mobile terminal that shares many components. In particular, according to the present invention, it has been realized that the GPS receiver function and some celestial or terrestrial radiotelephone standards share a common IF bandwidth. Moreover, some celestial or terrestrial radiotelephone standards share a common task to process a signal to find long code lengths therein. Thus, the only major remaining difference may be the different radio frequencies that are received.

Wireless mobile terminals according to the present invention include a GPS Radio Frequency (RF) receiver and a wide bandwidth radiotelephone RF receiver having bandwidth that is at least half as wide as the GPS signal chip frequency. The wireless mobile terminals also include a shared Intermediate Frequency (IF) section that is responsive to both the GPS RF receiver and to the wide bandwidth radiotelephone RF receiver. A demodulator is responsive to the shared IF section. Thus, common circuitry may be provided except for the GPS RF front end and wide bandwidth radiotelephone RF front end, which operate at different frequencies. However, both front ends may be manufactured in a single, dual-band front end for low cost manufacturing. High efficiency operations may thereby be provided.

In a preferred embodiment of the present invention, the wide bandwidth radiotelephone RF receiver is a Code Division Multiple Access (CDMA) RF receiver, including a Universal Mobile Terminal System (UMTS), also known as wideband CDMA, or a Time Division Multiple Access (TDMA) RF receiver. Both CDMA and TDMA RF receivers may have bandwidth on the order of 1MHz wide, which is comparable to GPS bandwidths. Thus, apart from the different RF spectra that are received, many components can be shared. For CDMA, the demodulator is preferably a CDMA spread spectrum despreader. For TDMA, the demodulator is preferably a TDMA demodulator.

In fact, due to the similar bandwidths, a combined GPS/CDMA receiver can be provided wherein the CDMA receiver has the identical bandwidth as the GPS receiver. In this case, IF and demodulation can be combined efficiently.

Portions of the GPS RF receiver and the TDMA/CDMA RF receiver can also be combined. For example, a dual band antenna may be provided wherein the GPS RF receiver includes a GPS RF filter that is responsive to the dual band antenna and wherein the wide bandwidth radiotelephone RF receiver comprises a spread spectrum RF filter that is responsive to the dual band antenna. A shared wide bandwidth RF amplifier and filter may then be provided in the RF section.

Other embodiments of the present invention may provide separate GPS and CDMA/TDMA IF sections wherein all components are separate or wherein some components such as a local oscillator are shared. In yet other embodiments, a common demodulator such as a despreader is provided, but all other components are separate.

Methods of receiving wireless communications in a mobile terminal according to the invention include the steps of receiving GPS RF signals at a predetermined chip frequency on a first RF channel and receiving wide bandwidth radiotelephone RF signals on a second RF channel, wherein the wide bandwidth radiotelephone RF signals have bandwidth that is at least half as wide as the GPS RF signal chip frequency. The GPS RF signals and the wide bandwidth radiotelephone RF signals are then demodulated in a shared demodulator. The demodulator can include a shared mixer. Accordingly, high efficiency, low cost wireless mobile terminals and wireless communication receiving methods may be provided.

Brief Description of the Drawings

Figure 1 illustrates a conventional terrestrial (cellular) wireless communication system.

Figure 2 illustrates a conventional celestial (satellite) wireless communication system.

Figure 3 illustrates a global positioning system (GPS).

Figures 4-9 are block diagrams of wireless mobile terminals and wireless communication receiving methods according to the present invention.

Figure 10 graphically illustrates correlation loss caused by filtering in a GPS receiver.

Detailed Description of Preferred Embodiments

The present invention now will be described more fully hereinafter with reference to the accompanying drawings, in which preferred embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to

the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. Like numbers refer to like elements throughout.

The present invention stems from the realization that the GPS receiver function and some radiotelephone standards share a common IF bandwidth and that some of these standards also share a common task to process a signal to find a long code length. Accordingly, components of a GPS receiver and a wide bandwidth radiotelephone receiver may be efficiently combined to produce wireless mobile terminals and receiving methods that are capable of efficient, low cost operation.

The details of GPS systems and wide bandwidth radiotelephone systems such as CDMA and TDMA systems are well known to those having skill in the art, and need not be described in detail below. Similarly, the subsystems that comprise each of these systems are also well known to those having skill in the art and need not be described in detail. Accordingly, the present Detailed Description will describe, on a block diagram level, various embodiments that can illustrate efficient combination of GPS receivers and wide bandwidth radiotelephone receivers.

Referring now to Figure 4, wireless mobile terminals and wireless communication receiving methods according to the present invention are shown. As shown in Figure 4, wireless mobile terminals and methods according to the present invention include a GPS RF receiver **410** and a wide bandwidth radiotelephone RF receiver **420** having bandwidth that is at least half as wide as that of the GPS RF signal chip frequency. A shared IF section **430** is responsive to both the GPS RF receiver **410** and to the wide bandwidth radiotelephone RF receiver **420**. A demodulator such as a despreader **450** is responsive to the shared IF section.

Preferably, the wide bandwidth radiotelephone RF receiver **420** is a CDMA or TDMA RF receiver. Also preferably, the GPS RF receiver **410** and the wide bandwidth radiotelephone RF receiver **420** have similar bandwidth in different RF spectra. Most preferably, the GPS RF receiver **410** and the wide

bandwidth radiotelephone RF receiver **420** have identical bandwidth in different RF spectra.

More particularly, there are many cellular telephone standards that have IF bandwidths of about 30KHz, such as the AMPS or digital AMPS standard, or about 270KHz, such as the GSM standard. These narrow bandwidths may be insufficient for receiving the 1MHz wide GPS signal. However, there are many cellular telephone standards that do have IF bandwidths of at least 1MHz. These include the IS-95 CDMA standard with a bandwidth of 1.2MHz, the Digital European Cordless Telephone (DECT) TDMA standard having a bandwidth of about 1MHz and a proposed Japanese CDMA standard having a bandwidth of up to 5MHz wide. Satellite communication systems are also being designed and developed having similar wide bandwidths as well as CDMA signal processing, such as GLOBALSTAR. Accordingly, the present invention can provide shared IF processing of the GPS and wide bandwidth radiotelephone signals and a shared despreading process including demodulation/correlation/ baseband processing. Accommodation may be made for the differing RF frequencies that are received at similar bandwidths.

In particular, it is known that the correlation loss caused by filtering in a GPS receiver is a function of the ratio of bandwidth to frequency. This correlation loss rapidly increases for bandwidths that are less than 50% of the chip frequency. See Figure 10, which is a reproduction of Figure 12 of the textbook entitled *"Global Positioning System: Theory and Applications, Vol. 1"*, p. 351, the disclosure of which is hereby incorporated herein by reference. For example, if the chipping rate is 1.023MHz, and if up to a 3dB loss is acceptable, then the single-sided bandwidth (half bandwidth) of the receiver can be 0.25 x 1.023MHz or about 255KHz. The total bandwidth is then about 511KHz, or about half the chip rate. As shown in Figure 10, at lower bandwidths, correlation loss increases rapidly.

Figure 5 illustrates another general embodiment of the present invention. In this embodiment, a separate GPS RF receiver **510** and wide bandwidth radiotelephone RF receiver **520** are provided, as well as a separate

GPS IF section **530** and wide bandwidth radiotelephone IF section **540**. A common demodulator such as despreader **550** is also provided. This embodiment may be desirable where it is preferred to provide separate IF sections.

Referring now to Figure 6, a more detailed embodiment of combined GPS/wide bandwidth radiotelephone terminals and methods is illustrated. As shown in Figure 6, a GPS RF section includes GPS antenna **612**, RF filter **614**, RF amplifier **616** and RF filter **618**. The wide bandwidth radiotelephone RF section includes cellular antenna **611**, RF filter **613**, RF amplifier **615** and RF filter **617**. A separate GPS mixer **630** and wide bandwidth radiotelephone mixer **640** is provided, each of which uses a separate local oscillator **632** and **642** respectively. A switch **644** is provided to switch between the GPS and wide bandwidth radiotelephone systems. A shared IF filter **646** and a shared demodulator such as despreader **650** (demodulator/ correlator/base band processor) is provided. Similarly, a common microprocessor **652** and memory **654** is provided.

It will be understood by those having skill in the art that the terminals and methods of Figure 6 may be obtained by adding GPS antenna **612**, RF filter **614**, RF amplifier **616**, RF filter **618**, mixer **630**, local oscillator **632** and switch **644** to a conventional CDMA cellular telephone terminal, to permit the combined unit to act in a dual mode GPS/CDMA mode depending on the setting of switch **644** and the digital processing of the signal in the correlator/base band processor **650** and microprocessor **652**. The software may need to be adjusted to search for different codes and slightly different code chip rates, and then use that information appropriately for either task.

For GPS reception, the code phase shifts may be found for each satellite that is visible, and data demodulation may permit time and ephemeris data to be obtained. Within the microprocessor **652**, the data is combined to determine location. In cellular telephone usage, the code polarity is data that is further processed in a CODEC to produce voice reception. It will also be understood that, for clarity, Figure 6 does not illustrate the transmit path that is used in a CDMA cellular telephone terminal.

It will also be understood that in the terminals and methods of Figure 6, code phase shifts may be obtained for each satellite that is visible, as determined from an internal almanac or from information supplied via a cellular telephone link. That information may be stored in the memory **654**, and then modes may be switched from GPS reception to CDMA cellular telephone usage. That code phase shift information may be sent over the cellular telephone link to a server where the location is determined using additional information that is obtained at a central point.

Referring now to Figure 7, an alternate embodiment of the present invention is illustrated. The elements of Figure 7 correspond to those of Figure 6 except that a common oscillator **732** is used for both the GPS mixer **630** and the wide bandwidth radiotelephone mixer **640**. The use of a common local oscillator in a dual mode GPS/radiotelephone terminal is described in Application Serial No. 08/925,566, entitled *"Systems and Methods for Sharing Reference Frequency Signals Within a Wireless Mobile Terminal Between a Wireless Transceiver and a Global Positioning System Receiver"*, to coinventors Horton and Camp, Jr., assigned to the assignee of the present invention, the disclosure of which is hereby incorporated herein by reference. In the embodiment of Figure 7, the circuit that controls the oscillator **732** may be adjusted to supply the appropriate frequency signal and permit reception of either GPS or wide band radiotelephone signals.

Figure 8 illustrates another embodiment wherein a common mixer **830** and a common local oscillator **832** are provided. Thus, switch **844** is used to switch the two RF signals into the mixer **830**. As with Figure 7, the oscillator may be readjusted to supply the appropriate frequency signal.

Similar architectures may be used for GPS/DECT and GPS/WCS terminals and methods. In DECT, which does not have a correlator function, digital hardware may need to be supplied with a firmware/software program to perform correlation within the digital resources.

Referring now to Figure 9, terminals and methods that share portions of the RF system are shown. As shown in Figure 9, a dual band GPS and cellular antenna **910** can receive both GPS and wide band radiotelephone

signals. A pair of switches **911** and **912** may be used to switch an appropriate GPS RF filter **914** or cellular filter **913**. Although these filters are shown as being separate filters, they may be embodied as a shared filter with variable or switched elements. A wide band RF amplifier **915** is then provided, along with a mixer **830**. Oscillator **832**, IF filter **646**, despreader **650**, microprocessor **652** and memory **654**, are also provided as was already described. It will also be understood that separate GPS and cellular antennas may be used rather than a dual band GPS and cellular antenna, in combination with a common wide band amplifier.

In the drawings and specification, there have been disclosed typical preferred embodiments of the invention and, although specific terms are employed, they are used in a generic and descriptive sense only and not for purposes of limitation, the scope of the invention being set forth in the following claims.

What is Claimed is:

1. A wireless mobile terminal for a wireless communications system, comprising:

a Global Positioning System (GPS) Radio Frequency (RF) receiver that receives GPS signals at a predetermined chip frequency;

a wide bandwidth radiotelephone RF receiver having bandwidth that is at least half as wide as the predetermined chip frequency;

a shared Intermediate Frequency (IF) section that is responsive to both the GPS RF receiver and to the wide bandwidth radiotelephone RF receiver; and

a demodulator that is responsive to the shared IF section.

2. A wireless mobile terminal according to Claim 1 wherein the wide bandwidth radiotelephone RF receiver is a Code Division Multiple Access (CDMA) RF receiver and wherein the demodulator is a CDMA despreader.

3. A wireless mobile terminal according to Claim 1 wherein the wide bandwidth radiotelephone RF receiver is a Time Division Multiple Access (TDMA) RF receiver and wherein the demodulator is a TDMA demodulator.

4. A wireless mobile terminal according to Claim 1 wherein the GPS RF receiver and the wide bandwidth radiotelephone RF receiver have similar bandwidth in different RF spectra.

5. A wireless mobile terminal according to Claim 1 wherein the GPS RF receiver and the wide bandwidth radiotelephone RF receiver have identical bandwidth in different RF spectra.

6. A wireless mobile terminal according to Claim 1 wherein the GPS RF receiver comprises a GPS antenna and wherein the wide bandwidth

radiotelephone RF receiver comprises a wide bandwidth radiotelephone antenna.

7. A wireless mobile terminal according to Claim 1 further comprising a dual band antenna, wherein the GPS RF receiver comprises a GPS RF filter that is responsive to the dual band antenna and wherein the wide bandwidth radiotelephone RF receiver comprises a spread spectrum RF filter that is responsive to the dual band antenna.

8. A wireless mobile terminal according to Claim 7 further comprising a wideband RF amplifier that is responsive to the GPS RF filter and the wide bandwidth radiotelephone RF filter.

9. A method of receiving wireless communications in a mobile terminal comprising the steps of:

receiving Global Positioning System (GPS) Radio Frequency (RF) signals at a predetermined chip frequency on a first RF channel;

receiving wide bandwidth radiotelephone RF signals on a second RF channel, wherein the wide bandwidth radiotelephone RF signals have bandwidth that is at least half as wide as the predetermined chip frequency; and

demodulating both the GPS RF signals and the wide bandwidth radiotelephone RF signals in a shared demodulator.

10. A method according to Claim 9 wherein the wide bandwidth radiotelephone RF signals are Code Division Multiple Access (CDMA) RF signals, and wherein the demodulating step comprises the step of despreading both the GPS RF signals and the wide bandwidth radiotelephone RF signals in a shared despreader.

11. A method according to Claim 9 wherein the wide bandwidth radiotelephone RF signals are Time Division Multiple Access (TDMA) RF signals.

12. A method according to Claim 9 wherein the GPS RF signals and the wide bandwidth radiotelephone RF signals have similar bandwidth in different RF spectra.

13. A method according to Claim 9 wherein the GPS RF signals and the wide bandwidth radiotelephone RF signals have identical bandwidth in different RF spectra.

14. A method according to Claim 9 wherein the demodulating step comprises the step of mixing both the GPS RF signals and the wide bandwidth radiotelephone RF signals in a shared mixer.

15. A wireless mobile terminal for a wireless communications system, comprising:

a Global Positioning System (GPS) Radio Frequency (RF) receiver that receives GPS signals at a predetermined chip frequency;

a wide bandwidth radiotelephone RF receiver having bandwidth that is at least half as wide as the predetermined chip frequency;

a GPS Intermediate Frequency (IF) section that is responsive to the GPS RF receiver;

a wide bandwidth radiotelephone IF section that is responsive to the wide bandwidth radiotelephone RF receiver; and

a shared demodulator that is responsive to both the GPS IF section and to the wide bandwidth radiotelephone IF section.

16. A wireless mobile terminal according to Claim 15 wherein the wide bandwidth radiotelephone RF receiver is a Code Division Multiple

Access (CDMA) RF receiver and wherein the shared demodulator is a shared spread spectrum despreader.

17. A wireless mobile terminal according to Claim 15 wherein the wide bandwidth radiotelephone RF receiver is a Time Division Multiple Access (TDMA) RF receiver.

18. A wireless mobile terminal according to Claim 15 wherein the GPS RF receiver and the wide bandwidth radiotelephone RF receiver have similar bandwidth in different RF spectra.

19. A wireless mobile terminal according to Claim 15 wherein the GPS RF receiver and the wide bandwidth radiotelephone RF receiver have identical bandwidth in different RF spectra.

20. A wireless mobile terminal according to Claim 15 wherein the GPS RF receiver comprises a GPS antenna and wherein the wide bandwidth radiotelephone RF receiver comprises a wide bandwidth radiotelephone antenna.

21. A wireless mobile terminal according to Claim 15 wherein the GPS IF section and the wide bandwidth radiotelephone IF section comprise a shared local oscillator.

22. A method of receiving wireless communications in a mobile terminal comprising the steps of:

receiving Global Positioning System (GPS) Radio Frequency (RF) signals at a predetermined chip frequency on a first RF channel;

receiving wide bandwidth radiotelephone signals on a second RF channel, wherein the wide bandwidth radiotelephone signals have bandwidth at least half as wide as the predetermined chip frequency;

separately mixing the GPS RF signals and the wide bandwidth radiotelephone signals in separate GPS and wide bandwidth radiotelephone mixers; and

demodulating both the mixed GPS RF signals and the mixed wide bandwidth radiotelephone signals in a shared demodulator.

23. A method according to Claim 22 wherein the wide bandwidth radiotelephone RF signals are Code Division Multiple Access (CDMA) RF signals, and wherein the demodulating step comprises the step of despreading both the mixed GPS RF signals and the mixed wide bandwidth radiotelephone signals in a shared despreader.

24. A method according to Claim 22 wherein the wide bandwidth radiotelephone RF signals are Time Division Multiple Access (TDMA) RF signals.

25. A method according to Claim 22 wherein the GPS RF signals and the wide bandwidth radiotelephone RF signals have similar bandwidth in different RF spectra.

26. A method according to Claim 22 wherein the GPS RF signals and the wide bandwidth radiotelephone RF signals have identical bandwidth in different RF spectra.

27. A wireless mobile terminal for a wireless communications system, comprising:

a global positioning system (GPS) receiver that receives GPS signals at a predetermined chip frequency; and

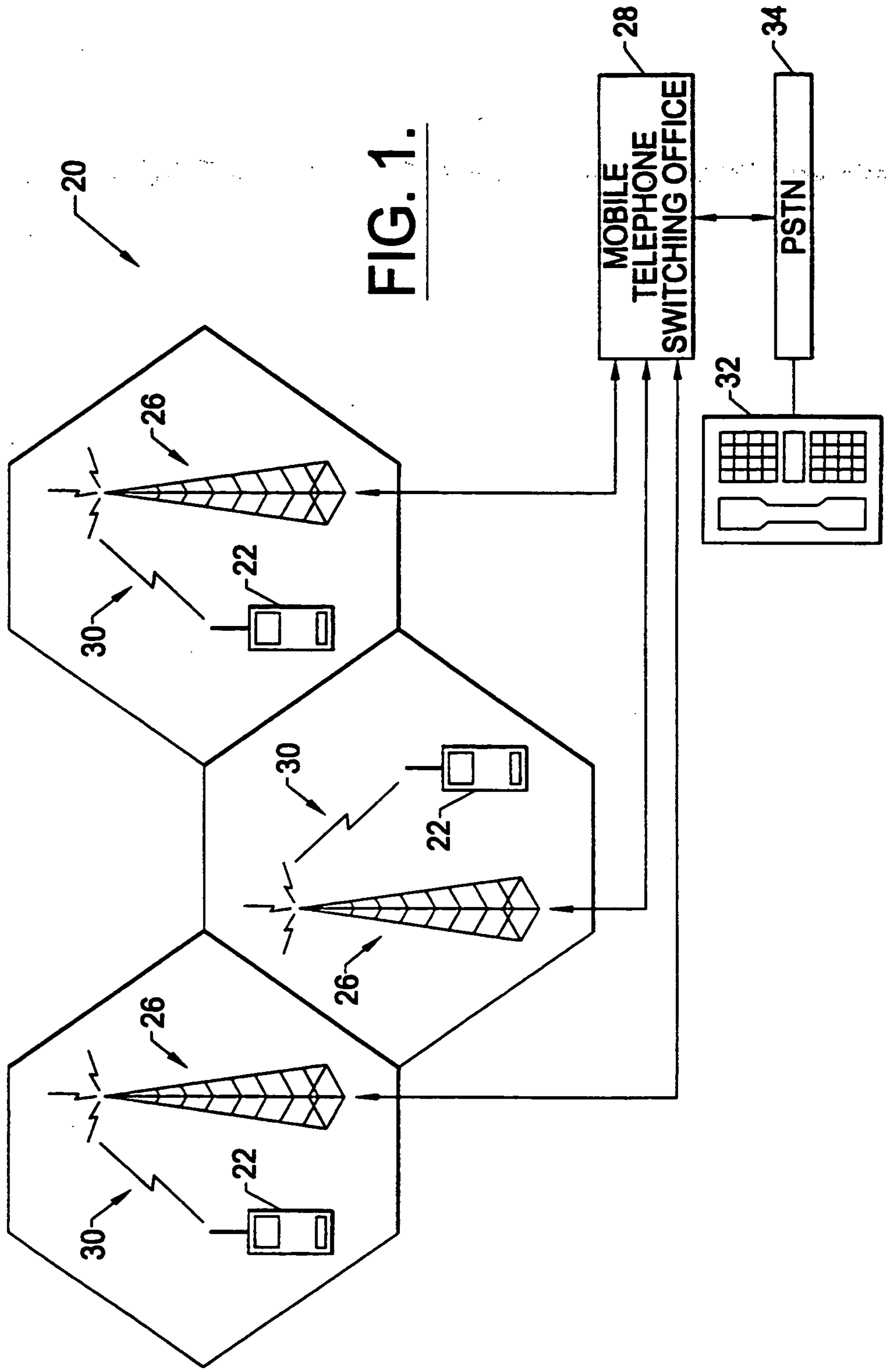
a wide bandwidth radiotelephone receiver having bandwidth at least half as wide as the predetermined chip frequency;

wherein the GPS receiver and the wide bandwidth radiotelephone receiver share a demodulator.

28. A wireless mobile terminal according to Claim 27 wherein the wherein the GPS receiver and the wide bandwidth radiotelephone receiver also share a mixer.

29. A wireless mobile terminal according to Claim 27 wherein the wide bandwidth radiotelephone receiver is a Code Division Multiple Access (CDMA) receiver and wherein the demodulator is a spread spectrum despreader.

30. A wireless mobile terminal according to Claim 27 wherein the GPS receiver and the wide bandwidth radiotelephone receiver have identical bandwidth in different radio frequency spectra.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28
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FIG. 1.

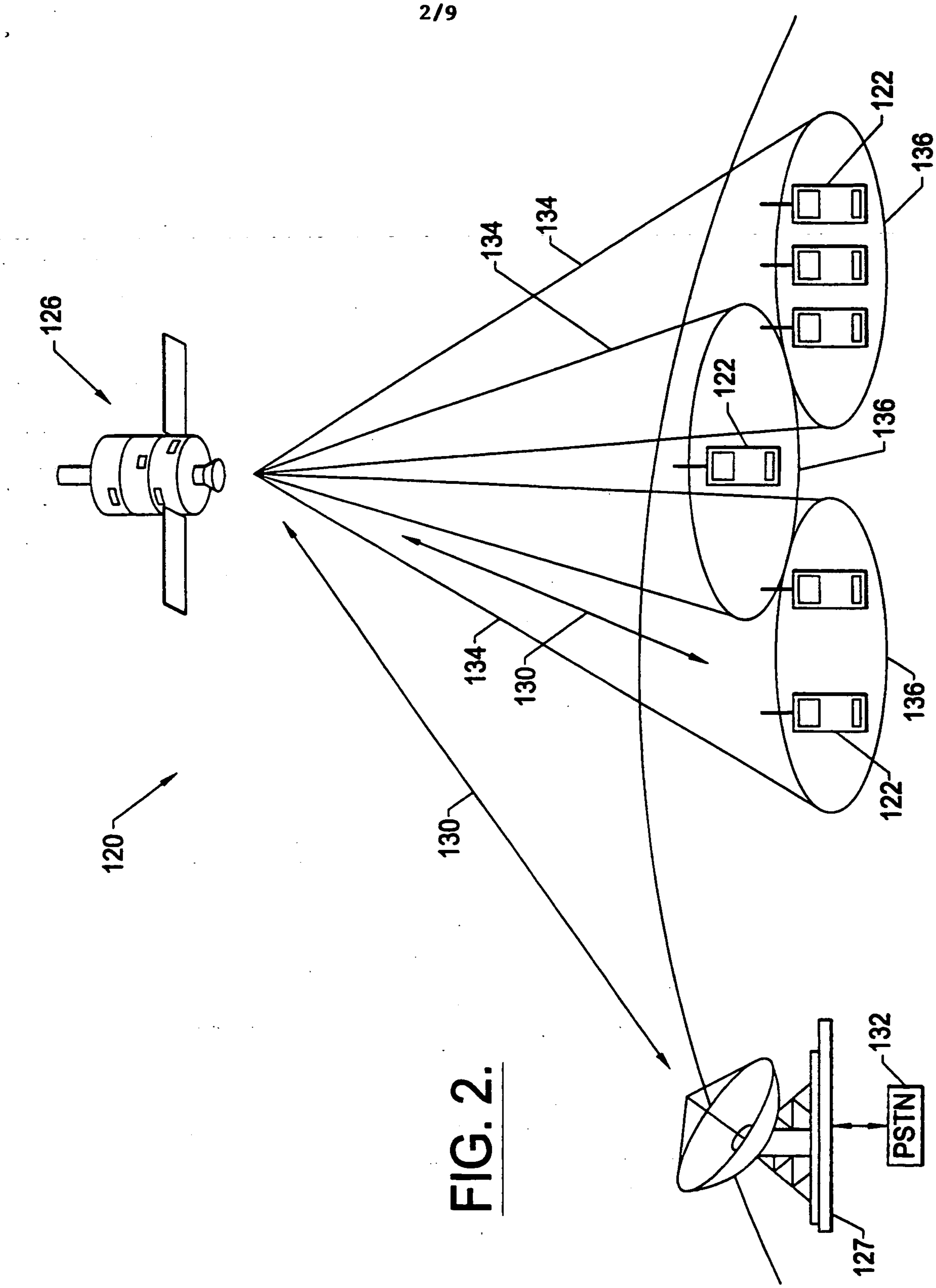


FIG. 2.

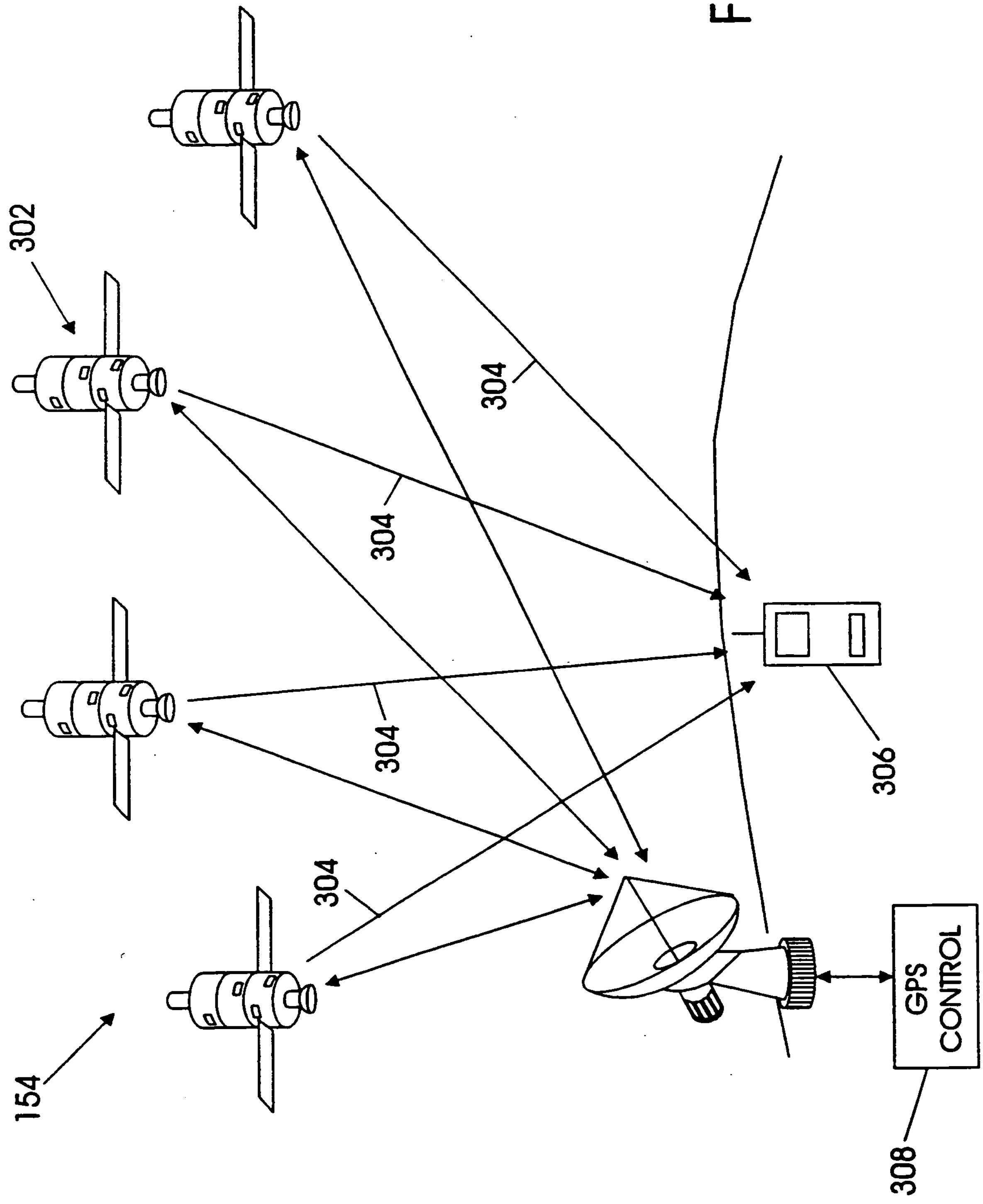


FIG. 3

FIG. 4

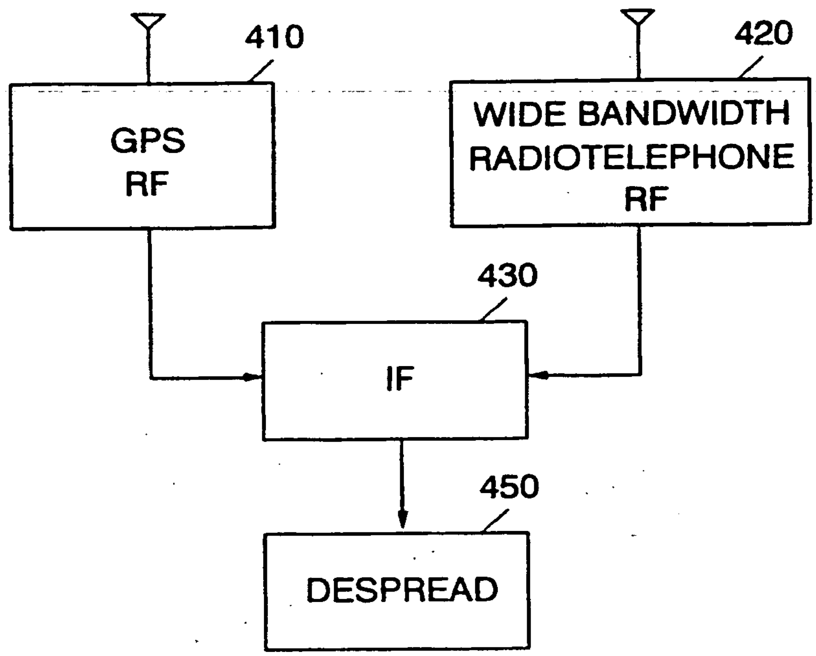

410
GPS
RF
420
WIDE BANDWIDTH
RADIOTELEPHONE
RF
430
IF
450
DESPREAD

FIG. 5

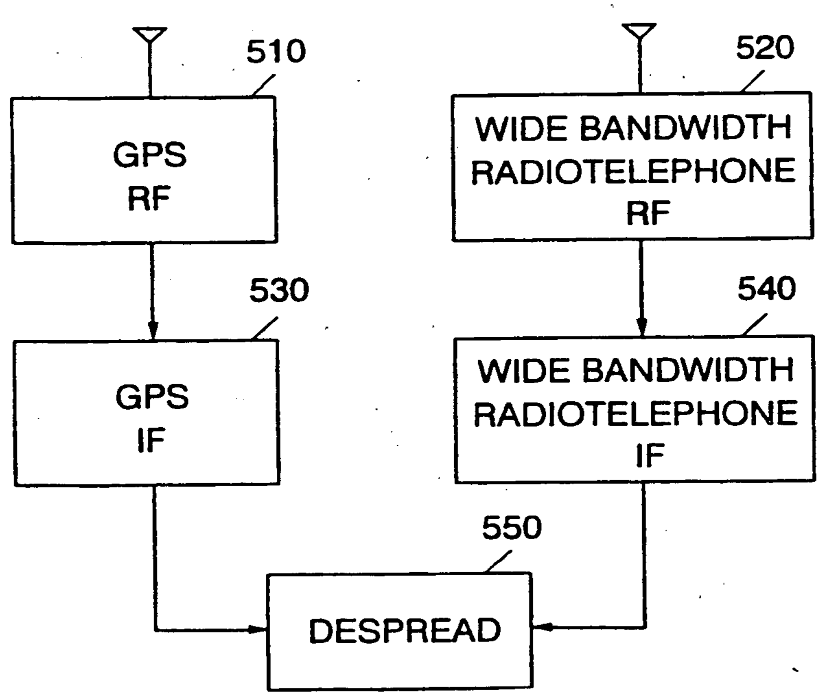

510
GPS
RF
520
WIDE BANDWIDTH
RADIOTELEPHONE
RF
530
GPS
IF
540
WIDE BANDWIDTH
RADIOTELEPHONE
IF
550
DESPREAD

FIG. 6

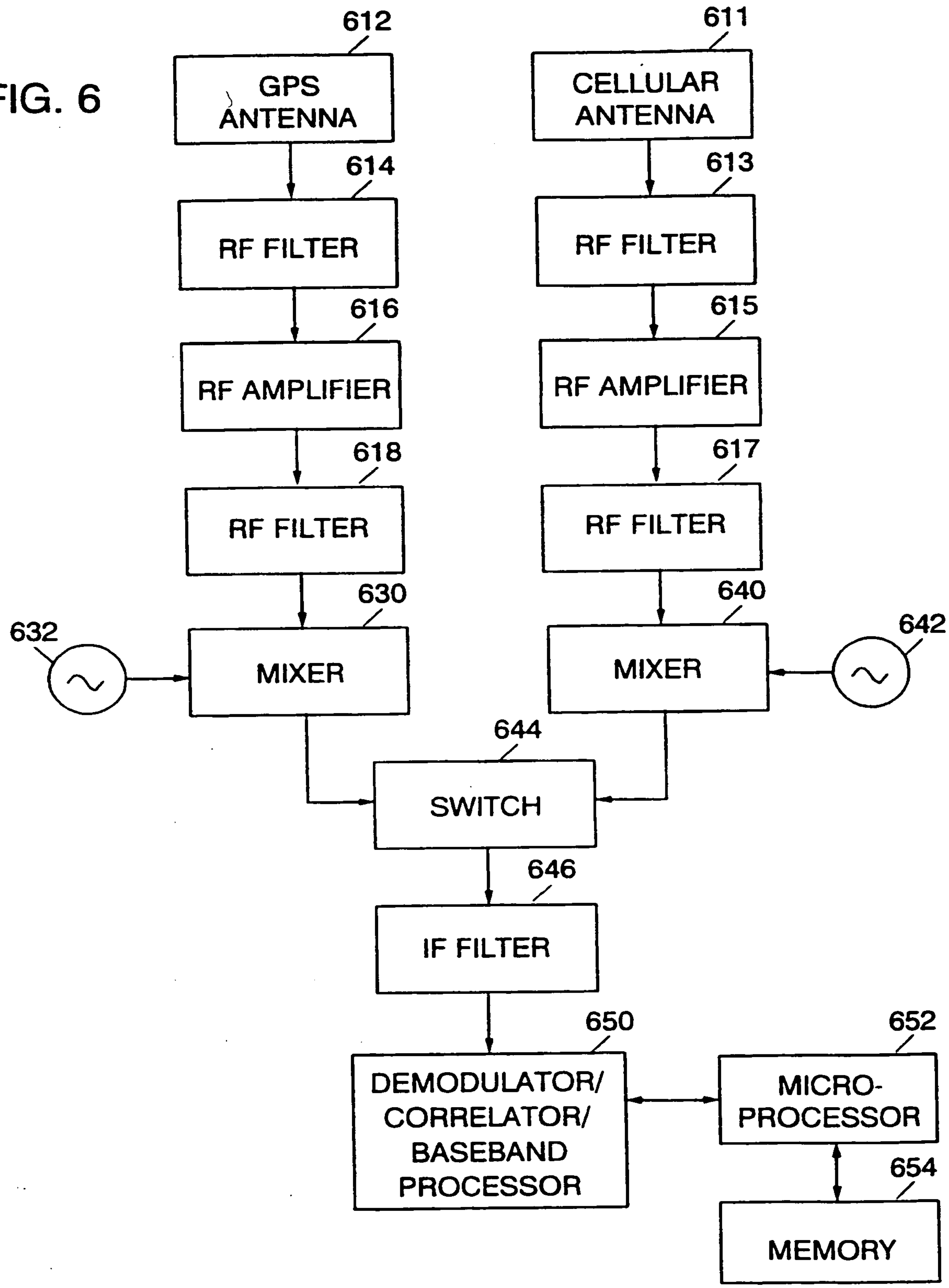

612
GPS ANTENNA
611
CELLULAR ANTENNA
614
RF FILTER
613
RF FILTER
616
RF AMPLIFIER
615
RF AMPLIFIER
618
RF FILTER
617
RF FILTER
630
MIXER
632
640
MIXER
642
644
SWITCH
646
IF FILTER
650
DEMODULATOR/ CORRELATOR/ BASEBAND PROCESSOR
652
MICRO-PROCESSOR
654
MEMORY

FIG. 7

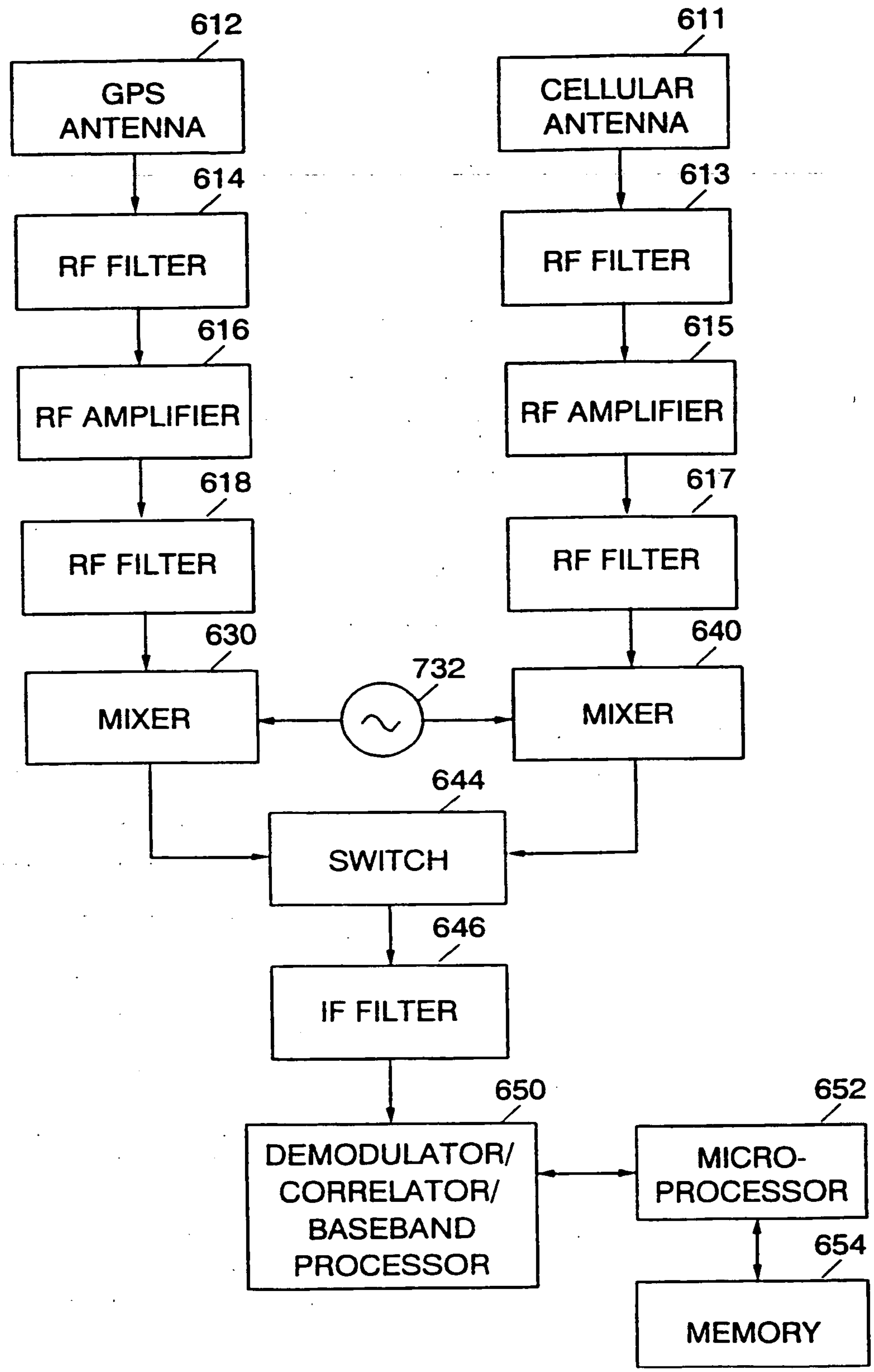

612
GPS ANTENNA
611
CELLULAR ANTENNA
614
RF FILTER
613
RF FILTER
616
RF AMPLIFIER
615
RF AMPLIFIER
618
RF FILTER
617
RF FILTER
630
MIXER
732
640
MIXER
644
SWITCH
646
IF FILTER
650
DEMODULATOR/ CORRELATOR/ BASEBAND PROCESSOR
652
MICRO-PROCESSOR
654
MEMORY

FIG. 8

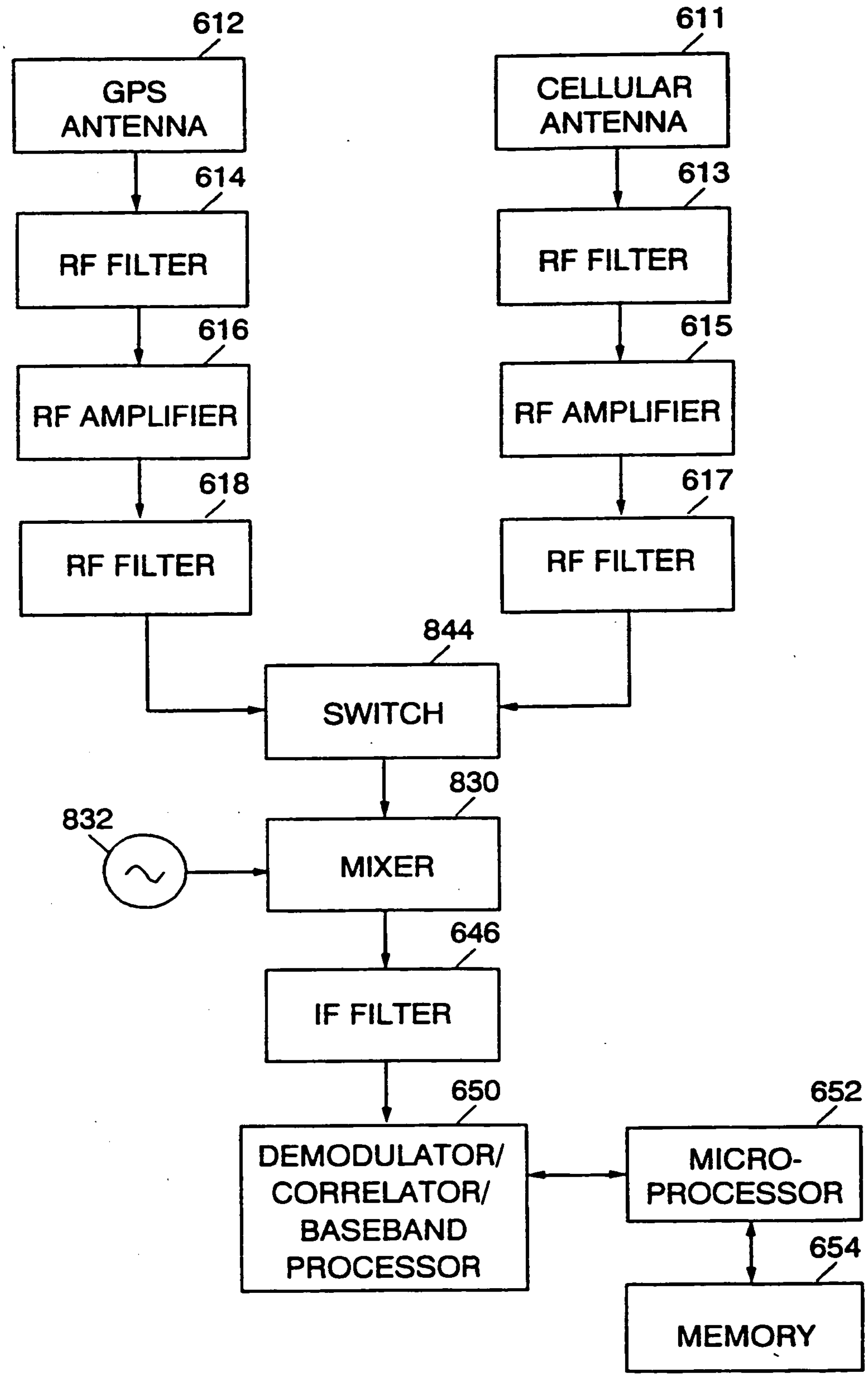

612
GPS ANTENNA
614
RF FILTER
616
RF AMPLIFIER
618
RF FILTER
611
CELLULAR ANTENNA
613
RF FILTER
615
RF AMPLIFIER
617
RF FILTER
844
SWITCH
830
832
MIXER
646
IF FILTER
650
DEMODULATOR/ CORRELATOR/ BASEBAND PROCESSOR
652
MICRO-PROCESSOR
654
MEMORY

FIG. 9

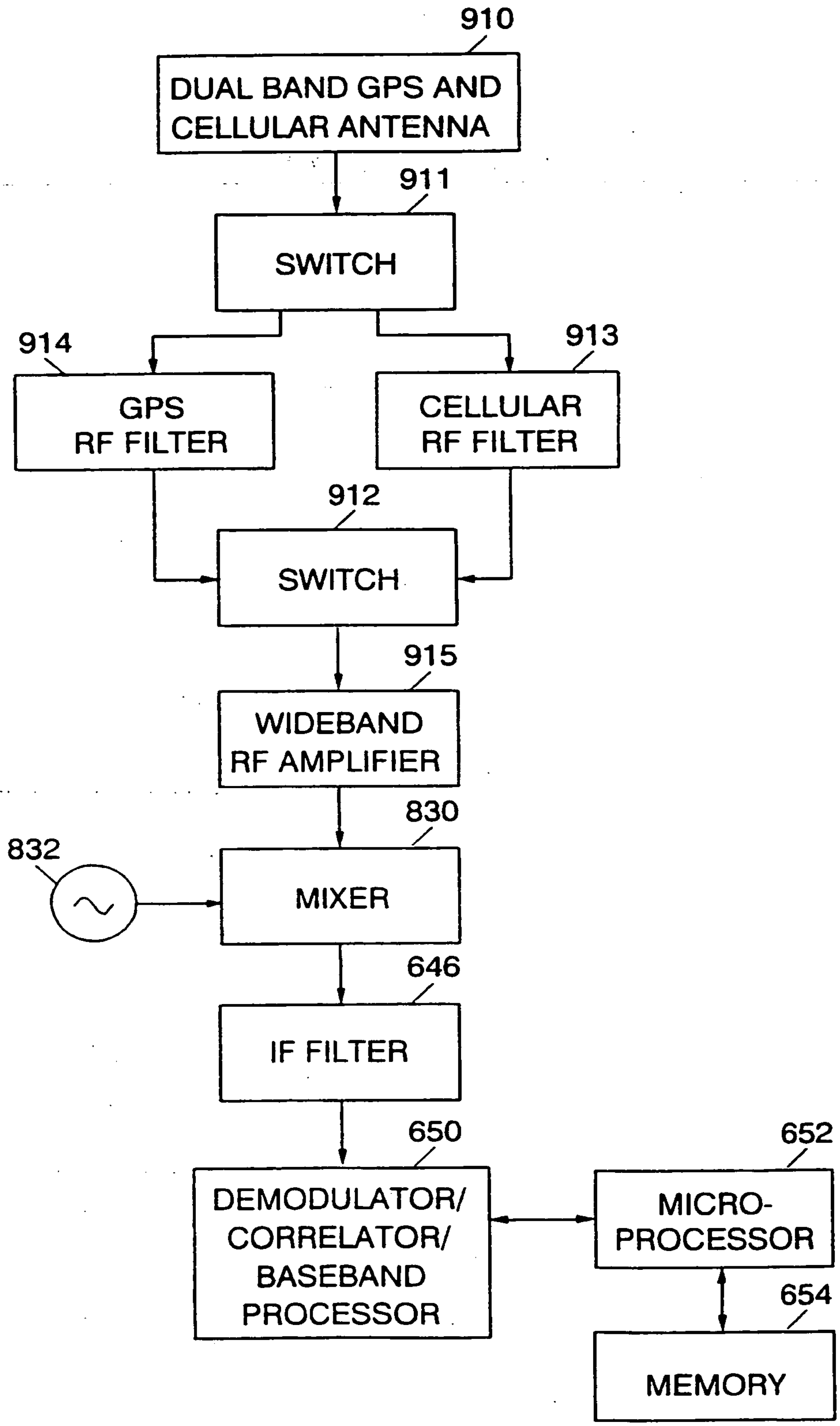
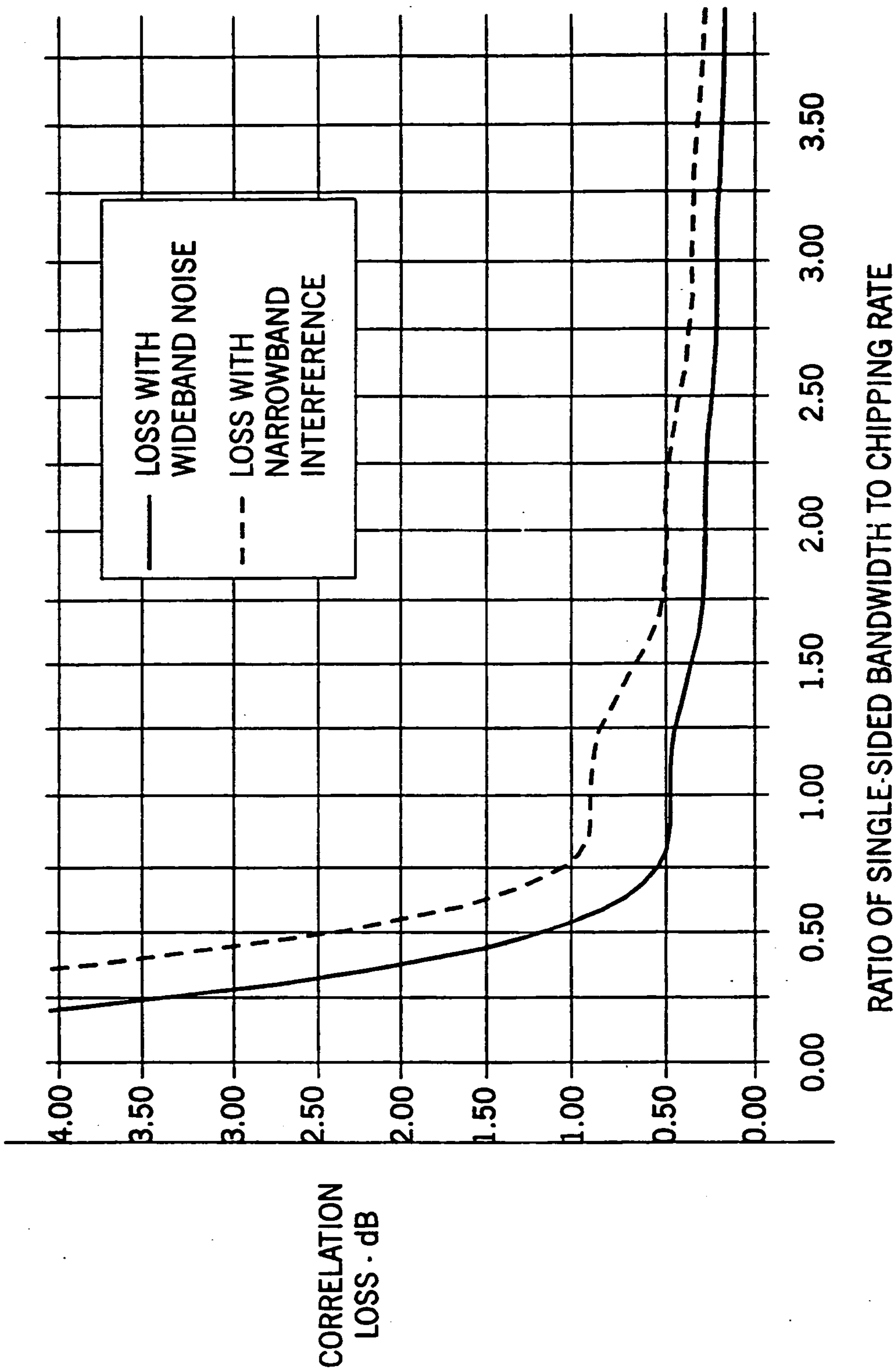

910
DUAL BAND GPS AND CELLULAR ANTENNA
911
SWITCH
914
GPS RF FILTER
913
CELLULAR RF FILTER
912
SWITCH
915
WIDEBAND RF AMPLIFIER
830
832
MIXER
646
IF FILTER
650
DEMODULATOR/ CORRELATOR/ BASEBAND PROCESSOR
652
MICRO-PROCESSOR
654
MEMORY

FIG. 10


LOSS WITH WIDEBAND NOISE
LOSS WITH NARROWBAND INTERFERENCE
CORRELATION LOSS - dB
RATIO OF SINGLE-SIDED BANDWIDTH TO CHIPPING RATE
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 98/24641

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04B1/38 G01S5/14 H04B1/26

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H04B H04Q G01S

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 97 14056 A (SNAPTRACK INC) 17 April 1997	1,4,6-9, 12,14, 15,18, 20-22, 25,27,28
A	see abstract	2,3,5, 10,11, 13,16, 17,19, 23,24, 26,29,30
	see figure 1A see figure 1B see figure 7A see figure 7B see page 2, line 14 - page 3, line 23 see page 4, line 22 - page 9, line 2 see page 21, line 3 - page 23, line 15 ---	

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 March 1999	23/03/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Lindhardt, U

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INTERNATIONAL SEARCH REPORT

Intern. al Application No
PCT/US 98/24641

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
P,X	EP 0 871 342 A (ALSTHOM CGE ALCATEL) 14 October 1998	1,3,4,8, 9,11,12, 14,15, 17,18, 21,22, 24,25, 27,28
A	see the whole document	2,5-8, 10,13, 16,19, 20,23, 26,29,30

1

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US 98/24641

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		CN 1199468 A	18-11-1998
		EP 0880713 A	02-12-1998
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		EP 0855039 A	29-07-1998
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		WO 9714054 A	17-04-1997
		WO 9714055 A	17-04-1997
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		WO 9714057 A	17-04-1997
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		US 5781156 A	14-07-1998
EP 0871342 A	14-10-1998	FR 2762168 A	16-10-1998
		CN 1197362 A	28-10-1998
		JP 10322754 A	04-12-1998